Late Acceptance Multiple Neighbourhood Search for Lock Planning

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The lock planning problem aims at transferring a number of ships, which arrive within a certain time horizon, in the most efficient way. The problem requires a multi-objective approach: minimize the number of turnings of the lock by arranging different ships into the chambers and minimize the waiting time for each ship. This waiting time is the time between the arrival of a ship and the turning time of the ship.

We applied a multiple neighbourhood search approach to the lock planning problem. In this approach the neighbourhoods are explored separately using the same starting solution. The best resulting solution from these searches is selected as the new starting solution for the multiple neighbourhood search. This process is repeated until none of the neighbourhoods generate improvements.

When exploring the neighbourhoods, a candidate solution is accepted if it satisfies the Late Acceptance criterion. It depends on one parameter L only, which is the length of the acceptance list. A candidate solution will be compared to the solution that was 'current' L steps before. Increasing this parameter will allow more worsening moves, and thus help avoiding local optima. When several improving moves exist, the best of them will be selected to update the acceptance list.

To validate this new approach, we generated several test instances for the lock planning problem. We carried out experiments with different heuristic optimisation methods: the multiple neighbourhood search with the late acceptance criterion, the multiple neighbourhood search with the best improving criterion and the late acceptance and the best improving criterion applied to all the neighbourhoods at the same time. The multiple neighbourhood search with the late acceptance criterion performs better than all the other methods, within a comparable amount of calculation time.